ENVIRONMENTAL SCIENCE
GRADES 10-12

EWING PUBLIC SCHOOLS
2099 Pennington Road
Ewing, NJ 08618

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In accordance with The Ewing Public Schools' Policy 2230, Course Guides, this curriculum has been reviewed and found to be in compliance with all policies and all affirmative action criteria.

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Course Description

This course provides an investigative approach to the interrelationships of the natural world through the study of the fundamental concepts, principles and methodologies of environmental science, with an emphasis on inquiry and critical thinking skills including problem solving and experimental investigations. Environmental science is interdisciplinary, covering a wide variety of topics from different areas of study including life science, the physical sciences and earth science. Topics covered in this course will include:

- Earth Systems and Resources
- The Living World
- Population
- Land and Water Use
- Energy Resources and Consumption
- Pollution
- Global Change

The course aligns to the Next Generation Science Standards (NGSS) with a focus on students mastering both content and science and engineering practices. The NGSS performance expectations strongly reflect the many societally relevant aspects of environmental science (resources, hazards, environmental impacts and sustainable use of resources) with an emphasis on using engineering and technology concepts to design solutions to challenges facing human society.

Students use the eight NGSS Science and Engineering Practices to demonstrate understanding of the disciplinary core ideas:

- Asking questions (science) and defining problems (engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using math and computational thinking
- Constructing explanations (science) and designing solutions (engineering)
- Engaging in argument from evidence
- Obtaining, evaluating and communicating information

The following seven crosscutting concepts identified within the NGSS support the development of a deeper understanding of the disciplinary core ideas:

- Patterns
- Cause and effect: mechanism and explanation
- Scale, proportion and quantity
- Systems and system models
- Energy and matter: flows, cycles and conservation
- Structure and function
- Stability and change

The course follows a block semester schedule, with students meeting daily for 88 minutes.

Career Readiness, Life Literacies, and Key Skills

During this course, students will work on developing, to an age appropriate level, the following Career Readiness, Life Literacies, and Key Skills:

Disciplinary Concepts:

- Career Awareness and Planning
  - An individual's strengths, lifestyle goals, choices, and interests affect employment and income.
  - Developing and implementing an action plan is an essential step for achieving one's personal and professional goals.
  - Communication skills and responsible behavior in addition to education, experience, certifications, and skills are all factors that affect employment and income.

- Creativity and Innovation
  - Gathering and evaluating knowledge and information from a variety of sources, including global perspectives, fosters creativity and innovative thinking.
- Critical Thinking and Problem-solving
  - Multiple solutions exist to solve a problem.
  - An essential aspect of problem solving is being able to self-reflect on why possible solutions for solving problems were or were not successful.
- Digital Citizenship
  - Detailed examples exist to illustrate crediting others when incorporating their digital artifacts in one's own work.
  - Digital communities are used by Individuals to share information, organize, and engage around issues and topics of interest.
  - Digital technology and data can be leveraged by communities to address effects of climate change.
- Global and Cultural Awareness

  - Awareness of and appreciation for cultural differences is critical to avoid barriers to productive and positive interaction.
- Information and Media Literacy
  - Increases in the quantity of information available through electronic means have heightened the need to check sources for possible distortion, exaggeration, or misrepresentation.

- Digital tools make it possible to analyze and interpret data, including text, images, and sound. These tools allow for broad concepts and data to be more effectively communicated.
- Sources of information are evaluated for accuracy and relevance when considering the use of information.
- There are ethical and unethical uses of information and media.

- Technology Literacy
  - Some digital tools are appropriate for gathering, organizing, analyzing, and presenting information, while other types of digital tools are appropriate for creating text, visualizations, models, and communicating with others. • Digital tools allow for remote collaboration and rapid sharing of ideas unrestricted by geographic location or time.

Technology Integration

<u>Computer Science and Design Thinking</u>
During this course, students will work on developing, to an age appropriate level, the following Computer Science and Design Thinking Skills:

Disciplinary Concepts and Core Ideas:

- Data & Analysis
  - People use digital devices and tools to automate the collection, use, and transformation of data.
  - The manner in which data is collected and transformed is influenced by the type of digital device(s) available and the intended use of the data.
  - Data is represented in many formats. Software tools translate the low-level representation of bits into a form understandable by individuals. Data is organized and accessible based on the application used to store it.
  - The purpose of cleaning data is to remove errors and make it easier for computers to process.
  - Computer models can be used to simulate events, examine theories and inferences, or make predictions.
- Engineering Design
  - Engineering design is a systematic, creative and iterative process used to address local and global problems.
  - The process includes generating ideas, choosing the best solution, and making, testing, and redesigning models or prototypes.

        - Engineering design requirements and specifications involve making trade-offs between competing requirements and desired design features.
    - Interaction of Technology and Humans
        - Economic, political, social, and cultural aspects of society drive development of new technological products, processes, and systems.
        - Technology interacts with society, sometimes bringing about changes in a society's economy, politics, and culture, and often leading to the creation of new needs and wants.
        - New needs and wants may create strains on local economies and workforces.
        - Improvements in technology are intended to make the completion of tasks easier, safer, and/or more efficient.
    - Nature of Technology
        - Technology advances through the processes of innovation and invention which relies upon the imaginative and inventive nature of people.
        - Sometimes a technology developed for one purpose is adapted to serve other purposes.
        - Engineers use a systematic process of creating or modifying technologies that is fueled and constrained by physical laws, cultural norms, and economic resources. Scientists use systematic investigation to understand the natural world.
    - Effects of Technology on the Natural World
        - Resources need to be utilized wisely to have positive effects on the environment and society.
- Some technological decisions involve trade-offs between environmental and economic needs, while others have positive effects for both the economy and environment.

ELA Integration:

NJSLS.RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem

NJSLS.RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

NJSLS.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

NJSLS.RST.11-12.8 Evaluate the hypotheses, data, analysis and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

NJSLS.SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning and well-chosen details; use appropriate eye contact, adequate volume and clear pronunciation.

NJSLS.SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual and interactive elements) in presentations to enhance understanding of findings, reasoning and evidence and to add interest.

NJSLS.WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

NJSLS.WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

NJSLS.WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection and research.

NJSLS.WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Math Integration:

NJSLS.MP.2 Reason abstractly and quantitatively.

NJSLS.MP.4 Model with mathematics.

NJSLS.HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

NJSLS.HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

NJSLS.HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

NJSLS.HSS-IC.A.1Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

NJSLS.HSS-ID.A.1Represent data with plots on the real number line.

Unit 1: Humans and Sustainability: An Overview
Recommended Pacing - 10 days

Why Is This Unit Important?

We depend on our environment. We enjoy it and the condition of our environment has a large effect on the quality of our lives. People can only live in an environment with certain kinds of characteristics and within certain ranges of availability of resources. Because modern science and technology give us the power to affect the environment, we have to understand how the environment works, so that we can live within its constraints.

Enduring Understandings:

- A more sustainable future will require that we rely more on energy from the sun and other renewable energy resources, protect biodiversity through the preservation of natural capital and avoid disrupting the earth's vitally important chemical cycles.
- A major goal for becoming more sustainable is full-cost pricing—the inclusion of harmful environmental and health costs in the market prices of goods and services.
- We will benefit ourselves and future generations if we commit ourselves to finding win-win-win solutions to our problems and to leaving the planet's life-support system in at least as good a shape as what we now enjoy.

Essential Questions:

- What are some principles of sustainability?
- How are our ecological footprints affecting the earth?
- Why do we have environmental problems?
- What is an environmentally sustainable society?

Acquired Knowledge:

<u>ESS2.D: Weather and Climate</u>:

- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HSESS3-6)

<u>ESS3.A: Natural Resources</u>:

- Resource availability has guided the development of human society . (HS-ESS3-1)

- All forms of energy production and other resource extraction have associated economic, social, environmental and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

ESS3.B: Natural Hazards:

- Natural hazards and other geologic events have shaped the course of human history ; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) ESS3.C: Human Impacts on Earth Systems
- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

ET S1.B: Developing Possible Solution:

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HS-ESS3-2) (secondary HS-ESS3-4)

Acquired Skills:

Analyzing and Interpreting Data:

- Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency and the use of models to generate and analyze data.
    - Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

Using Mathematics and Computational Thinking:

- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms and computational tools for statistical analysis to analyze, represent and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
    - Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS - ESS3-3)
    - Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

Constructing Explanations and Designing Solutions:

- Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific knowledge, principles and theories.
    - Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1)
    - Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria and tradeoff considerations. (HS-ESS3-4)

Engaging in Argument from Evidence:

- Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
    - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

Assessments:

Formative Assessments:

- Group discussions
- Observation
- Homework
- Class work
- Class participation
- Lab work
- Quizzes

Summative Assessments:

- Renewable – non-renewable energy resource analysis
- Full Price Cost analysis to determine sustainability level
- Unit test

Benchmarks:

- Students will be assessed on their ability to construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity
- Students will be assessed on their ability to evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Alternative Assessments:

- Modified project requirements and rubrics

Suggested Labs/Activities:

Anticipatory Set:

- Daily essential questions for covered topic

In Class Activities and Laboratory Experiences:

- Ecological footprint
- Video: Secrets of the Lost Empires 2
- Four Corners (Six Tables)
- 'Tragedy of the Commons'
- Video: The Lorax
- Wants and needs activity
- Global wheel energy analysis
- Making Informed Decisions
- http://gallery.usgs.gov/video/oregon_science_podcast/2012/OWSC_episode04_082312.mp4

Closure and Reflection Activities:

- Journal about essential questions and reflect on how they are connected

Instructional Materials:

- Global wheel copies, scissors, glue and flat paper fasteners
- Internet / computer research
- http://gallery.usgs.gov/video/oregon_science_podcast/2012/OWSC_episode04_082312.mp4

Technology Connections:

- Calculate Your Carbon Footprint
- My Local Environment (EPA)
- http://gallery.usgs.gov/video/oregon_science_podcast/2012/OWSC_episode04_082312.mp4
- http://education.nationalgeographic.org/lesson/making-informed-environmental-decisions
- http://water.epa.gov/drink/contaminants/index.cfm
- http://gallery.usgs.gov/video/oregon_science_podcast/2012/OWSC_episode04_082312.mp4
- http://www.sciencedaily.com/releases/2015/09/150903121719.htm

Accommodations or Modifications for Special Education, ESL or Gifted Learners:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards and changes in climate have influenced human activity
- HS-ESS3-2. Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.
- HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations and biodiversity
- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity

Unit 2: The Living World
Recommended Pacing - 12 days

Why Is This Unit Important?

Flow of energy and matter in ecosystems are essential to the species that live in them. However, sometimes ecosystems experience major disturbances that alter how they operate. Disturbances can occur over both short and long time scales and how these disturbances impact the ecosystem and whether or not the ecosystem can recover and how long it will take are of particular interest.

Enduring Understandings:

- You cannot really throw anything away. According to the *law of the conservation of matter*, no atoms are created or destroyed whenever matter undergoes physical change. Thus we cannot do away with matter; we can only change it from one physical state or chemical form to another.
- Life is sustained by the flow of energy from the sun through the biosphere, the cycling of nutrients within the biosphere and gravity.
- Some organisms produce the nutrients they need, others survive by consuming other organisms and still others live on the wastes and remains of organisms while recycling nutrients that are used again by producer organisms.
- Human activities are altering the flow of energy through food chains and webs and the cycling of nutrients within ecosystems and the biosphere.
- Populations evolve when genes mutate and give some individuals genetic traits that enhance their abilities to survive and to produce offspring with these traits (natural selection).
- Human activities are degrading the Earth's vital biodiversity by hastening the extinction of species and by disrupting habitats needed for the development of new species.
- Each species plays a specific ecological role (its ecological niche) in the ecosystem where it is found.
- We are hastening the extinction of wild species and degrading the ecosystem services they provide by destroying and degrading their habitats, introducing harmful invasive species and increasing human population growth, pollution, climate change and overexploitation.
- We should avoid causing the extinction of wild species because of the ecosystem and economic services they provide and because their existence should not depend primarily on their usefulness to us.
- We can work to prevent the extinction of species and to protect overall biodiversity and ecosystem services by using laws and treaties, protecting wildlife sanctuaries and making greater use of the precautionary principle.

Essential Questions:

- What is matter and what happens when it undergoes change?
- What are systems and how do they respond to change?
- How does the earth's life-support system work?
- What are the major components of an ecosystem?
- What happens to matter and energy in an ecosystem?
- What is biodiversity and why is it important?
- How does the earth's life change over time?
- How do geological processes and climate change affect evolution?
- How do speciation, extinction and human activities affect biodiversity?
- What is species diversity and why is it important?
- What roles do species play in ecosystems?
- What role do humans play in the loss of species and ecosystem services?
- Why should we care about sustaining species and the ecosystems services they provide?
- How do humans accelerate species extinction and degradation of ecosystem services?
- How can we sustain wild species and their ecosystem services?

Acquired Knowledge:

LS2.A: Interdependent Relationships in Ecosystems:

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2- 1) (HS-LS2-2)

LS2.C: Ecosystem Dynamics, Functioning and Resilience:

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2) (HS-LS2-6)
- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

Acquired Skills:

Using Mathematics and Computational Thinking:

- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms and computational tools for statistical analysis to analyze, represent and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
    - Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HSLS2-1)
    - Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

Constructing Explanations and Designing Solutions:

- Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.
    - Design, evaluate and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria and tradeoff considerations. (HS-LS2-7)
- Engaging in Argument from Evidence Engaging in argument from evidence in 9-12 builds from K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
    - Evaluate the claims, evidence and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)

Suggested Labs/Activities:

Anticipatory Set:

- Daily essential questions for covered topic

In Class Activities and Laboratory Experiences:

- Cats in Borneo
- Owl pellet biomass
- Soil Analysis Lab
- Biodiversity analysis lab
- Evolution and Adaptation: Using Wooly Worms and other Creatures to Simulate Natural Selection
- Video; Cane Toads

- 'Hotspot' Travel Brochure
- Analysis of Primary Productivity in Aquatic Ecosystems
- Food Web activity
- Biogeochemical cycle games
- EPA.gov Climate Student activities, CO_2 annual change and CO_2 vs temperature

Closure and Reflection Activities:

- Journal about essential questions and reflect on how they are connected

Assessments:

Formative Assessments:

- Group discussions
- Observation
- Homework
- Class work
- Class participation
- Lab work
- Quizzes

Summative Assessments:

- Biodiversity Lab
- Ecosystem Stability Analysis
- Unit test

Benchmarks:

- Students will be assessed on their ability to evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- Students will be assessed on their ability to design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity

Alternative Assessments:

- Modified project requirements and rubrics

Instructional Materials:

- Energy in the Ecosystem WebQuest http://www.zephyrus.co.uk/foodpuzzlechain.html
- Owl pellets, dissecting materials and lab sheets
- Carbon Model- closed bottle ecosystem
- Climate Change CO_2 monthly vs. yearly data tables, graph paper and calculators
- Climate Change CO_2 vs. temp graphs

Technology Connections:

- Biodiversity Brochure
- Endangered Species Activity
- Exotic Species Mini-Project
- Biodiversity Lab
- http://www.zephyrus.co.uk/foodpuzzlechain.html
- Why care about Biodiversity
- 'bottle ecosystem'
- Sample Diagram of Bottle Ecosystem
- Building a Bottle Ecosystem
- Ecosystems
- Biotic and Abiotic Factors
- Communities and Species Interactions
- Biodiversity
- Nutrient Cycles

Accommodations or Modifications for Special Education, ESL or Gifted Learners:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales
- HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem
- HS-LS2-6 Evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- HS-LS2-7 Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Unit 3: Population
Recommended Pacing - 15 days

Why Is This Unit Important?

Populations of all species range from very small to very large encompassing a variety of ranges across the planet. Interactions among species affect its growth and distribution. Humans have the widest range of all species on the planet. In our quest for energy and resources, we are significantly, possibly irrevocably, altering the size and distribution of these populations, including our own. As the most technologically advanced species on the planet, it is our responsibility to correct the damage we have done to other populations, as well as our own.

Enduring Understandings:

- Certain interactions among species affect their use of resources and their population sizes.
- Changes in environmental conditions cause communities and ecosystems to gradually alter their species composition and population sizes (ecological succession).
- There are always limits to population growth in nature. The human population is growing rapidly and may soon bump up against environmental limits.
- Even if population growth is not a problem, the increasing use of resources per person is expanding the overall human ecological footprint and putting a strain on the Earth's resources.
- We can slow human population growth by reducing poverty, elevating the status of women and encouraging family planning.

Essential Questions:

- How do species interact?
- How do communities and ecosystems respond to changing environmental conditions?
- What limits the growth of populations?
- How do environmental scientists think about human population growth?
- What factors influence the size of the human population?
- How does a population's age structure affect its growth or decline?
- How can we slow human population growth?

Acquired Knowledge:

ESS3.B: Natural Hazards:

- Natural hazards and other geologic events have shaped the course of human history ; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) ESS3.C: Human Impacts on Earth Systems The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

LS2.A: Interdependent Relationships in Ecosystems:

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2- 1) (HS-LS2-2)

LS2.C: Ecosystem Dynamics, Functioning and Resilience:

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2) (HS-LS2-6)

Acquired Skills:

Using Mathematics and Computational Thinking:

- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms and computational tools for statistical analysis to analyze, represent and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
    - Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS - ESS3-3)

- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms and computational tools for statistical analysis to analyze, represent and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
    - Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HSLS2-1)
    - Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

Suggested Activities:

Anticipatory Set:

- Daily essential questions for covered topic

In Class Activities and Laboratory Experiences:

- Reintroduction of the Lynx to a Rocky Mountain Forest: How Age Structure Diagrams Can be used to Determine Habitat Suitability
- Keystone Species: Core Case Study
- Population Pyramids
- The Power of Doubling
- Population distribution and Survivorship
- Simulating Methods to Estimate Population Size
- Predator-Prey Relationships
- Invasive Species
- Floristic Relay Game
- Human Population and Carrying Capacity WebQuest
- Survivorship Lab

Closure and Reflection Activities:

- Journal about essential questions and reflect on how they are connected

Assessments:

Formative Assessments:

- Group discussions
- Observation
- Homework
- Class work
- Class participation
- Lab work
- Quizzes

Summative Assessments:

- Keystone Species: Core Case Study
- Human Population and Carrying Capacity WebQuest
- Unit test

Benchmarks:

- Students will be assessed on their ability to use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- Students will be assessed on their ability to use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales

Alternative Assessments:

- Modified project requirements and rubrics

Instructional Materials:

- Age structure diagrams
- Population charts, calculators and graph paper
- Flood data for NJ coastline, computers
- Bubbles, hangers, timers

Technology Connections:

- Current World Population
- http://www.zephyrus.co.uk/foodpuzzlechain.html
- http://www.ck12.org///embed/#module=modality&handle=Ecosystems-BIO&mtype=lesson&context=Ecosystems&branch=biology&filters=all%2Ctext%2Cmultimedia%2Cactivities%2Cstudy_resource%2Cteaching_resource%2Creference%2Cassessment%2Csimulations%2Cweb_links%2Cmind_map%2Creal_world%2Cattachment%2Cinteractive%2Cother&view_mode=embed&nochrome=true
- http://kidwings.com/nests-of-knowledge/virtual-pellet/
- http://www.census.gov/ipc/www/popclockworld.html

Accommodations or Modifications for Special Education, ESL or Gifted Learners:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales,
- HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations and biodiversity.

Unit 4: Earth's Systems
Recommended Pacing - 15 days

Why Is This Unit Important?

The Earth is a dynamic system. It is constantly making changes. Normally, these changes occur naturally in a set progression. Humans have accelerated these phenomena or have caused them to occur in areas that they normally wouldn't. As nature responds, sometimes violently to our interference, we are often the recipients of her wrath. Understanding how these systems work will enable us to make more intelligent decisions to keep catastrophic responses from occurring or keeping the devastating effects to a minimum.

Enduring Understandings:

- Differences in climate, based mostly on long-term differences in average temperature and precipitation, largely determine the types and location of the Earth's deserts, grasslands and forests.
- The Earth's terrestrial ecosystems provide important ecosystem and economic services.
- Human activities are degrading and disrupting many of the ecosystem and economic services provided by the Earth's terrestrial ecosystems.
- Modern industrialized agriculture has a greater harmful impact on the environment than any other human activity.
- More sustainable forms of food production will greatly reduce the harmful environmental impacts of industrialized food production systems while likely increasing food security.
- Saltwater and freshwater aquatic life zones cover almost three-fourths of the Earth's surface and oceans dominate the planet.
- Certain human activities threaten biodiversity and disrupt ecosystem and economic services provided by aquatic ecosystems.
- The economic values of the important ecosystem services provided by the world's ecosystems are far greater than the value of raw materials obtained from those systems.
- We can manage forests, grasslands and nature reserves more effectively by protecting more land and by preventing overuse and degradation of these areas and the renewable resources they contain.
- We can sustain terrestrial biodiversity and ecosystem services by protecting biodiversity hotspots and ecosystem services, restoring damaged ecosystems and sharing with other species much of the land we dominate.
- The world's aquatic systems provide important economic and ecosystem services and scientific investigation of these poorly understood ecosystems could lead to immense ecological and economic benefits.
- Aquatic ecosystems and fisheries are being severely degraded by human activities that lead to aquatic habitat disruption and loss of biodiversity.
- We can sustain aquatic biodiversity by establishing protected sanctuaries, managing coastal development, reducing water pollution and preventing overfishing.

- One of the major global environmental problems is the growing shortage of freshwater in many parts of the world.
- We can expand water supplies in water-short areas in a number of ways, but the most important ways are to reduce overall water use and to use water much more efficiently.
- We can use water more sustainably by cutting water losses, raising water prices and protecting aquifers, forests and other ecosystems that store and release water.
- Outdoor air pollution, in the form of industrial smog, photochemical smog and acid deposition and indoor air pollution are serious global problems.
- Each year, at least 2.4 million people die prematurely from the effects of air pollution; indoor air pollution, primarily in less-developed countries, causes about two-thirds of these deaths.
- We need to give top priority status to the prevention of outdoor and indoor air pollution throughout the world and the reduction of stratospheric ozone depletion.
- Considerable scientific evidence indicates that the earth's atmosphere is warming, mostly because of human activities and that this is likely to lead to significant climate disruption during this century that could have severe and long-lasting harmful consequences.
- Reducing the projected harmful effects of rapid climate disruption during this century requires emergency action to increase energy efficiency, sharply reduce greenhouse gas emissions and rely more on renewable energy resources.
- While we can prepare for some climate change that is now inevitable, we could realize important economic, ecological and health benefits by drastically reducing greenhouse gas emissions with the goal of slowing climate change.
- There are a number of ways to purify drinking water, but the most effective and least costly strategy is pollution prevention.
- The key to protecting the world's oceans is to reduce the flow of pollution from land and air and from streams emptying into ocean waters.
- Reducing water pollution requires that we prevent it, work with nature in treating sewage and use natural resources far more efficiently.

Essential Questions:

- What environmental problems arise from industrialized food production?
- How can we produce more food sustainably?
- What factors influence climate?
- How does climate affect the nature and location of biomes?
- How have human activities affected the world's ecosystems?
- What is the general nature of aquatic ecosystems?
- Why are aquatic systems important?
- How should we maintain terrestrial ecosystems?
- What is the ecosystem approach to sustaining biodiversity and ecosystem services?
- What are the major threats to aquatic biodiversity and ecosystem services?

- How can we protect and sustain aquatic biodiversity?
- Will we have enough usable water?
- Is groundwater a sustainable resource?
- How can we use fresh water more sustainably?
- What are the earth's major geological processes and what are mineral resources?
- How long might supplies of nonrenewable mineral resources last?
- What are the environmental effects of using nonrenewable mineral resources?
- How can we use mineral resources more sustainably?
- What are the earth's major geological hazards?
- What is the structure of the atmosphere?
- What are the major air pollution problems?
- What is acid deposition and why is it a problem?
- How should we deal with air pollution?
- How have we depleted ozone in the stratosphere and what can we do about it?
- How and why is the earth's climate changing?
- What are the possible effects of a warmer atmosphere?
- What can we do to slow projected climate disruption?
- How can we adapt to climate change?
- What are the causes and effects of water pollution?
- How can we deal with water pollution?

Acquired Knowledge:

ESS1.B: Earth and the Solar System:

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

ESS2.A: Earth Materials and Systems:

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HSESS2-1) (HS-ESS2-2)
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

ESS2.B: Plate Tectonics and Large-Scale System Interactions:

- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (ESS2.B Grade 8 GBE) (HS-ESS2-1)

ESS2.C: The Roles of Water in Earth's Surface Processes:

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials and lower the viscosities and melting points of rocks. (HS-ESS2-5)

ESS2.D: Weather and Climate:

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage and redistribution among the atmosphere, ocean and land systems and this energy's re-radiation into space. (HS-ESS2-2) (HS-ESS2-4)
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6) (HS-ESS2-7) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2- 6) (HS-ESS2-4)

ESS2.E: Biogeology:

- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)

ESS3.A: Natural Resources:

- All forms of energy production and other resource extraction have associated economic, social, environmental and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

ESS3.B: Natural Hazards:

- Natural hazards and other geologic events have shaped the course of human history ; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) ESS3.C: Human Impacts on Earth Systems The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

Acquired Skills:

Using Mathematics and Computational Thinking:

- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms and computational tools for statistical analysis to analyze, represent and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
    - Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS - ESS3-3)

Developing and Using Models:

- Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
    - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1) (HS-ESS2- 3) (HS-ESS2-6)
    - Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

Planning and Carrying Out Investigations:

- Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models.
    - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence and in the design: decide on types, how much and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time) and refine the design accordingly. (HS-ESS2-5)

Analyzing and Interpreting Data:

- Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency and the use of models to generate and analyze data.
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2)

Engaging in Argument from Evidence:

- Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
    - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

Suggested Labs/Activities:

Anticipatory Set:

- Daily essential questions for covered topic

In Class Activities and Laboratory Experiences:

- Lab: Investigating Soils
- Solar Insulation of the Earth
- Determining the Health of a pond Ecosystem
- Elk and Vegetation Management Plan: Rocky Mountain National Park. CO
- Measuring and Monitoring Aquatic Conditions
- Desalinization Lab
- Lab: Graham Cracker Approach to Plate Tectonics
- Chocolate Chip Cookie Mining
- Liquefaction Simulation
- Video: Blue Gold
- Lab: Sewage Treatment
- Field Trip: Sewage Treatment plant
- Acid Deposition Activity
- How Hot is it Here on Earth?
- Drinking Water Safety (Coliscan Easygel method)
- Investigating the Effects of Ocean Acidification
- Indicating DO levels as an indicator of Aquatic Health
- What's in Your Water
- Smog City

Closure and Reflection Activities:

- Journal about essential questions and reflect on how they are connected

Assessments:

Formative Assessments:

- Group discussions
- Observation
- Homework
- Class work
- Class participation
- Lab work
- Quizzes

Summative Assessments:

- Desalinization Lab
- Lab: Sewage Treatment
- Unit test

Benchmarks:

- Students will be assessed on their ability to use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate
- Students will be assessed on their ability to construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards and changes in climate have influenced human activity.
- Students will be assessed on their ability to evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.

Alternative Assessments:

- Modified project requirements and rubrics

Instructional Materials:

- What's In Your Water lab data sheet, scenarios, computers, eye droppers, beakers, food dye
- Air Pollution Smog City, intro article, Air pollutants effects chart, scenario cards

Technology Connections:

- Soil Analysis Lab Worksheet
- https://www.youtube.com/watch?v=77ENELQUIf4
- http://ca.water.usgs.gov/data/drought/drought-water-decisions.html
- http://www.nytimes.com/interactive/2015/05/21/us/your-contribution-to-the-california-drought.html?_r=0
- http://water.epa.gov/drink/contaminants/index.cfm
- https://www.youtube.com/watch?v=Se12y9hSOM0
- http://water.epa.gov/type/rsl/drinkingwatermap.cfm
- https://www.teachengineering.org/view_activity.php?url=collection/uoh_/activities/uoh_drink/uoh_drink_activity01.xml
- https://www.idahopower.com/OurEnvironment/FishAquatic/hatcheryProgram/pahsimeroi.cfm
- http://batkoclassroom.weebly.com/career-connections.html
- www.epa.gov/climatestudents
- Audubon Drinking Water Report
- https://www.ck12.org/assessment/ui/views/test.view.new.html?practice/Carbon-Cycle-Practice?type=practice&referrer=featured_content&ep=https://www.ck12.org/biology/Carbon-Cycle/
- Carbon cycle article: http://www.earthobservatory.nasa.gov/Features/CarbonCycle/page1.php
- Lethal Seas video link (53 min): http://www.pbs.org/wgbh/nova/earth/lethal-seas.html#.VjAXwiS4Lv8.mailto
- The Ecology of Climate Change (8 min): http://www.amnh.org/explore/science-bulletins/(watch)/bio/documentaries/the-ecology-of-climate-change

Accommodations or Modifications for Special Education, ESL or Gifted Learners:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- HS-ESS2-4Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate
- HS-ESS2-5Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere and biosphere.
- HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards and changes in climate have influenced human activity.
- HS-ESS3-2 Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.*

Unit 5: Energy Resources and Consumption
Recommended Pacing - 18 days

Why Is This Unit Important?

As our population grows, our consumption of resources grows exponentially. Many of these resources are finite and will eventually no longer be available. In addition to being depleted, use of these energy sources has negative impacts on the environment. If we plan to maintain quality of life as we know it, we need to shift to cleaner, renewable energy resources.

Enduring Understandings:

- You cannot get something for nothing. According to the *first law of thermodynamics*, or the *law of conservation of energy*, whenever energy is converted from one form to another in a physical or chemical change, no energy is created or destroyed. This means that in causing such changes, we cannot get more energy out than what we put in.
- You cannot break even. According to the second law of thermodynamics, whenever energy is converted from one form to another in a physical or chemical change, we always end up with lower-quality or less usable energy than we started with.
- A key factor to consider in evaluating the long-term usefulness of any energy resource is its net energy yield.
- Conventional oil, natural gas and coal are plentiful and have moderate to high net energy yields, but use of these fossil fuels, especially coal, has a high environmental impact.
- The nuclear power fuel cycle has a low environmental impact and a very low accident risk, but high costs, a low net energy yield, long-lived radioactive wastes and its role in spreading nuclear weapons technology have limited its use.
- We should evaluate energy resources on the basis of their potential supplies, their net energy yields and the environmental health impacts of using them.
- By using a mix of renewable energy sources—especially solar, wind, flowing water, sustainable biofuels and geothermal energy—we could drastically reduce pollution, greenhouse gas emissions and biodiversity losses.
- Making the transition to a more sustainable energy future will require sharply increasing energy efficiency, using a mix of environmentally friendly renewable energy resources and including the harmful environmental and health costs of energy resources in their market prices.

Essential Questions:

- What is energy and what happens when it undergoes change?
- What is net energy and why is it important?
- What are the advantages and disadvantages of using oil, natural gas, coal and nuclear power?
- Why is energy efficiency an important energy resource?
- What are the advantages and disadvantages of using solar energy?
- What are the advantages and disadvantages of using hydropower?
- What are the advantages and disadvantages of using wind power?
- What are the advantages and disadvantages of using biomass as an energy resource?
- What are the advantages and disadvantages of using geothermal energy?
- What are the advantages and disadvantages of using hydrogen as an energy source?
- How can we make the transition to a more sustainable energy future?

Acquired Knowledge:

ESS3.A: Natural Resources:

- All forms of energy production and other resource extraction have associated economic, social, environmental and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

Acquired Skills:

Engaging in Argument from Evidence:

- Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
    - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

Suggested Labs/Activities:

Anticipatory Set:

- Daily essential questions for covered topic

In Class Activities and Laboratory Experiences:

- Solar Cooker
- Oil Spill Remediation Lab
- Fracking Activity
- Video: GasLand, GasLand II
- Biodiesel Fuel Exercise Part I
- Biodiesel Fuel Exercise Part II (If time allows)

Closure and Reflection Activities:

- Journal about essential questions and reflect on how they are connected

Assessments:

Formative Assessments:

- Group discussions
- Observation
- Homework
- Class work
- Class participation
- Lab work
- Quizzes

Summative Assessments:

- Fracking Activity
- Biodiesel Fuel Exercise
- Unit test

Benchmarks:

- Students will be assessed on their ability to evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.

Alternative Assessments:

- Modified project requirements and rubrics

Instructional Materials:

- Lab Kits

Technology Connections:

- www.epa.gov/climatestudents
- http://gallery.usgs.gov/video/oregon_science_podcast/2012/OWSC_episode04_082312.mp4
- Energy Problems and Car MPG
- Home Energy Use
- Geothermal Energy Animation
- Tidal Energy Animation
- Wave Energy Animation
- Wind Map
- Solar Energy Calculator

Accommodations or Modifications for Special Education, ESL or Gifted Learners:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-ESS3-2 Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.

Unit 6: Impacts (Economic, Environmental and Human Health)
Recommended Pacing - 20 days

Why Is This Unit Important?

As we make decisions in regards to the use of our planet, it is most often done based on monetary cost. In regards to this cost, a select few make the decisions and usually profit from them, while significantly larger numbers of individuals pay a very steep price. This price can be monetary in nature, degrading to their environment, or detrimental to their health. Since all systems on the planet are connected, it is imperative that we make smarter decisions that take into account the 'true value' of ecosystem services or eventually everyone will suffer.

Enduring Understandings:

- Making a transition to more sustainable economies will require finding ways to estimate and include the harmful environmental and health costs of producing goods and services in their market prices.
- Making this economic transition will also mean phasing out environmentally harmful subsidies and tax breaks and replacing them with environmentally beneficial subsidies and tax breaks.
- Another way to further this transition would be to tax pollution and wastes instead of wages and profits and to use most of the revenues from these taxes to promote environmental sustainability and reduce poverty.
- We face significant hazards from infectious diseases such as flu, AIDS, tuberculosis, diarrheal diseases and malaria and from exposure to chemicals that can cause cancers and birth defects and to those that can disrupt the human immune, nervous and endocrine systems.
- Because of the difficulty of evaluating the harm caused by exposure to chemicals, many health scientists call for much greater emphasis on pollution prevention.
- By becoming informed, thinking critically about risks and making careful choices, we can reduce the major risks we face.
- The order of priorities for dealing with solid waste should be to produce less of it, reuse and recycle as much of it as possible and safely burn or bury what is left.
- The order of priorities for dealing with hazardous waste should be to produce less of it, reuse or recycle it, convert it to less-hazardous material and safely store what is left.
- We need to view solid wastes as wasted resources and hazardous wastes as materials that we should not be producing in the first place
- Urbanization is increasing steadily and the numbers and sizes of urban areas are growing rapidly, especially in less-developed countries.
- Most urban areas are unsustainable with their large and growing ecological footprints and high levels of poverty.
- Urban areas can be made more sustainable and livable just as some cities and villages already are.

Essential Questions:

- How are economic systems related to the biosphere?
- How can we estimate the values of natural capital, pollution control and resource use?
- How can we use economic tools to deal with economic problems?
- How can reducing poverty help us deal with environmental problems?
- How can we make the transition to more environmentally sustainable economies?
- What major health hazards do we face?
- What types of biological hazards do we face?
- What types of chemical hazards do we face?
- How can we evaluate chemical hazards?
- How do we perceive risks and how can we avoid the worst of them?
- What are solid waste and hazardous waste and why are they problems?
- How should we deal with solid waste?
- Why are refusing, reducing, reusing and recycling so important?
- What are advantages and disadvantages of burning or burying solid waste?
- How should we deal with hazardous waste?
- How can we make the transition to a more sustainable low-waste society?
- What are the major population trends in urban areas?
- What are the major urban resource and environmental problems?
- How does transportation affect urban environmental impacts?
- How can cities become more sustainable and livable?

Acquired Knowledge:

LS4.C: Adaptation:

- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions and the decline-and sometimes the extinction-of some species. (HS-LS4-5)
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)

LS4.D: Biodiversity and Humans:

- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7), (HS-LS4-6)

ETS1.B: Developing Possible Solutions:

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HSLS2-7) (secondary to HS-LS4-6)
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to HS-LS4-6)

ESS2.D: Weather and Climate:

- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HS-ESS3-6)

ESS3.D: Global Climate Change:

- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

ET S1.B: Developing Possible Solutions:

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety , reliability and aesthetics and to consider social, cultural and environmental impacts. (HS-ETS1-3)

Acquired Skills:

Engaging in Argument from Evidence:

- Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.
    - Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)

Using Mathematics and Computational Thinking:

- Create or revise a simulation of a phenomenon, designed device, process or system. (HS-LS4-6)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

Constructing Explanations and Designing Solutions:

- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria and tradeoff considerations. (HS-ETS1-3)

Suggested Labs/Activities:

Anticipatory Set:

- Daily essential questions for covered topic

In Class Activities and Laboratory Experiences:

- Ecotourism Survey
- Video: No Impact Man
- Risk Assessment Lab
- Recycle City
- Green City Design Project
- Dose/Response Bioassay
- Clean Air School Lab
- Coral Reef engineering
- Sponge biomimicry engineering
- Famous Environmentalists Research Project
- Career Exploration: Environmental Engineer

Closure and Reflection Activities:

- Journal about essential questions and reflect on how they are connected

Assessments:

Formative Assessments:

- Group discussions
- Observation
- Homework
- Class work
- Class participation
- Lab work
- Quizzes

Summative Assessments:

- Risk Assessment Lab
- Green City Design Project
- Unit test

Benchmarks:

- Students will be assessed on their ability to evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time and (3) the extinction of other species.
- Students will be assessed on their ability to refine a technological solution that reduces impacts of human activities on natural systems.
- Students will be assessed on their ability to evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics, as well as possible social, cultural and environmental impacts

Alternative Assessments:

- Modified project requirements and rubrics

Instructional Materials:

- Clean Air School Lab handout Adapted from: http://www.earthday.org/sites/default/files/air_pollution_101_lesson_plan.pdf
- Computers/internet research

Technology Connections:

- http://www.mhhe.com/biosci/genbio/virtual_labs/BL_02/BL_02.html
- http://www.thegeoexchange.org/carboncycle/diagrams/animations.html
- http://www.thegeoexchange.org/carboncycle/candles.html
- http://www.bigelow.org/foodweb/carbon_cycle.jpg
- www.epa.gov/climatestudents
- http://airnow.gov/index.cfm?action=aqikids.games
- How to Use Smog City 2 Controls.

Accommodations or Modifications for Special Education, ESL or Gifted Learners:

- Accommodations or Modifications for Special Education: Teacher made worksheets, graphic organizers, study guides and other resources
- Accommodations or Modifications for Gifted Learners: Analyze and work with case studies to connect and extend lessons to the real world

List of Applicable Performance Expectations (PE) Covered in This Unit:

- HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time and (3) the extinction of other species.
- HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*
- HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
- HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity
- HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics, as well as possible social, cultural and environmental impacts.

Sample Standards Integration

Career Readiness, Life Literacies, and Key Skills

9.4.12.CI.1:

For example, in Unit 1, students do the 'Wants and Needs' activity.

9.4.12.CT.2:

For example, in Unit 4, students collaborate to analyze and determine the Health of a Pond

9.4.8.IML.3:

For example, in Unit 1, students collect and analyze data to conduct a Global Wheel Energy Analysis.

8.1 Computer Science and Design Thinking

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and create and communicate knowledge.

- For example in Unit 1, students will access, manage, evaluate, and synthesize information to plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- For example in Unit 3, students develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment when they evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural and environmental impacts.

LGBT and Disabilities Law:

In Unit 6 the Famous Environmentalists Research Project has students explore the contributions of famous environmentalists from varying minorities including those who are LGBTQ and have disabilities

Career Exploration:

- In Unit 6 there is a Career Exploration: Environmental Engineer

Interdisciplinary Connections

NJSLS.RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem

NJSLS.RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
NJSLS.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
NJSLS.RST.11-12.8 Evaluate the hypotheses, data, analysis and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
NJSLS.SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning and well-chosen details; use appropriate eye contact, adequate volume and clear pronunciation.
NJSLS.SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual and interactive elements) in presentations to enhance understanding of findings, reasoning and evidence and to add interest.
NJSLS.WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
NJSLS.WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
NJSLS.WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection and research.
NJSLS.WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

These standards are met through activities in all units. For example in:

- Unit 2: Tragedy of the Commons activity.
- Unit 3: Keystone Species: Core Case Study
- Unit 6: Risk Assessment.

NJSLS.MP.2 Reason abstractly and quantitatively.

NJSLS.MP.4 Model with mathematics.

NJSLS.HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

NJSLS.HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

NJSLS.HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

NJSLS.HSS-IC.A.1Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

NJSLS.HSS-ID.A.1Represent data with plots on the real number line.

These standards are met through the completion of activities in all units. For example in:

- Unit 2: Calculate Carbon Footprint.
- Unit 3: Simulating Methods to estimate Population Size.
- Unit 6: Risk Assessment activity.

Additional Useful Links for Environmental Science

- http://quizlet.com/ - a super awesome study tool. search 'kostenko,' or use the direct links here.
- http://www.mnn.com/ - Mother Nature Network. Environmental News and Information. Great place for extra credit articles. hint. hint.
- http://earth911.com/ - Earth 911. Environmental News and Information
- http://www.epa.gov/ - US Environmental Protection Agency
- http://www.state.nj.us/dep/fgw/index.htm - NJ Division of Fish and Wildlife
- http://www.nationsonline.org/ - information on nations of the world
- http://www.infoplease.com/countries.html - information on different countries
- http://www.nationmaster.com/countries - information on nations of the world
- http://www.earthday.net/ - the earth day network. where every day is earth day!
- http://www.footprintnetwork.org/en/index.php/GFN/page/personal_footprint/ - calculate your own ecological footprint.
- https://www.cia.gov/library/publications/the-world-factbook/fields/2119.html - world population fact book
- http://www.indexmundi.com/world/ - world information
- http://www.prb.org/DataFinder.aspx - world population information
- http://www.eahdfoundation.org/world_live_clock.php - world clock and statistics
- http://www.earthresource.org/campaigns/capp/capp-styrofoam.html - earth resource foundation and stance on polystyrene
- http://www.thecaloriecounter.com/ - information on the calorie content of various foods
- http://www.calorieking.com/foods/ - more information on the calorie content of various foods
- http://caloriecount.about.com/foods - information on the calorie content of various foods
- http://www.epa.gov/kidshometour/ - information about hazardous chemicals around your home (this site has it all. almost)
- http://hpd.nlm.nih.gov/index.htm - household products database, health and safety information (this site helps with products not mentioned on the EPA site)
- http://environmentalchemistry.com/ - environmental, chemistry and hazardous materials news, careers and resources (scroll down to hazardous materials, household)
- http://eartheasy.com/live_nontoxic_solutions.htm - natural alternatives to household cleaners
- http://ecommons.cornell.edu/bitstream/handle/1813/14553/fs22.safeUse_pesticides.pdf?sequence=1&isAllowed=y - safe storage of hazardous household chemicals
- http://www.aapcc.org/dnn/default.aspx - American Association of Poison Control Centers (the prevention page is particularly helpful)

- http://www.nps.gov/ - National Park Service
- http://www.state.nj.us/dep/parksandforests/ - NJ Division of Parks and Forestry
- http://www.stateparks.com/usa.html - information on state parks of the US
- http://www.storyofstuff.com/ - The Story of Stuff - see what happens to all you trash
- http://www.state.nj.us/dep/dshw/recycling/ - Information on recycling in NJ
- http://www.co.ocean.nj.us/SolidWaste/ContentPage.aspx?ID=322 - Ocean County Department of Solid Waste Management
- http://www.cdc.gov/ - center for disease control and prevention
- http://www.cdc.gov/ncidod/dvbid/Lyme/ - information on Lyme Disease
- http://www.aldf.com/ - information on Lyme Disease
- http://www.lymediseaseassociation.org/ - information on Lyme Disease
- http://njaes.rutgers.edu/weeds/ - weeds common in NJ
- http://www.arborday.org/trees/whattree/ - tree identification tool
- http://www.dendro.cnre.vt.edu - plant identification tool
- http://www.insectidentification.org/ - insect identification tool
- http://www.whatbird.com/ - bird identification tool
- http://www.enature.com/home/indexNew.asp - wildlife identification tool